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Influence of micro- and nanofillers on DEAP performance

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The formulation of dielectric electroactive polymers (DEAP) is a challenging task as the elastomer part of DEAP is a multi-component system with strict requirements to the electromechanical performance. In traditional formulated products such as paints there is a huge variety of filler materials available and the filler particles are used both to lower the price and to increase the performance of the material. In DEAP there is a strong interplay between the electrical and mechanical properties as one property may be improved and another worsened when changing the formulation so in many cases optimization of the properties ends in a trade-off of some kind.

In this study we focus on the addition of well-known commercially available filler particles and evaluate their performance in elastomers applied for DEAP since the price of the fillers also have to be taken into account when formulating. The effect of particle size and particle size distribution on the electrical and viscoelastic properties is investigated. Both nano- and microscale particles of different compositions are mixed with a platinum cured silicone elastomer matrix [1] in different combinations, and the dielectric and viscoelastic properties are measured.

The dielectric properties are improved mainly by decreasing the particle size as was also shown by Kofod et al [2] for acrylic networks whereas the elastic properties are influenced in a less trivial way. The filler particles increase the storage modulus and make the films easier to handle but the formulation of the 'raw' silicone matrix has to be modified as the filler particles in some instances interact with the polymers and hence require a changed stoichiometry to ensure complete reaction of both reactive species in the silicone matrix.

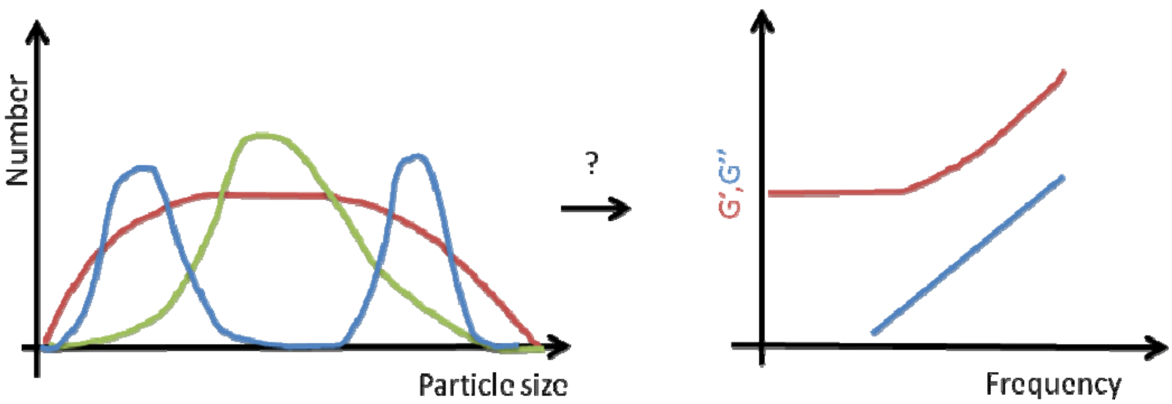

Figure: Illustrations of different particle size distributions and of an LVE diagram for a typical elastomer with a small degree of viscous dissipation.

References:
[1] A. L. Larsen,K. Hansen,P. Sommer-Larsen, O. Hassager, A. Bach, S. Ndoni, and M. Jørgensen, Macromolecules 2003, 36, 10063.
[2] Mc Carthy DN, Risse S, Katekomol P, Kofod G J., Physics D-Appl. Phys. 2009, 42, 14, 145406.